Space Weather Technical Forecast

Issued on Thursday 12 December 2024 at 01:02 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: Low to Moderate Solar Activity

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with three M-class flares, peaking with a M6.7 flare at 11/1549 UTC from the recently departed region AR3912. The next largest flare was from AR3920 at 11/1006 UTC at M2.8 and a M2.0 flare at 11/0604 UTC from AR3922. There are currently four active regions on the disc, with AR3920 now the largest after showing development in the last 24-48 hours and is the most magnetically complex, with evidence of a potential delta spot. AR3922 in the southeast of the disc, gave several M-class flares as it rotated around the southeast limb. However, this remains a small and relatively simple region in recent imagery, although it is proving difficult to analyse in its current location. AR3917 which is now moving across into the southwest disc, has shown some consolidation of its smaller spots into a few larger ones.

No Earth directed CMEs were observed, although a number of CMEs were visible in imagery, all considered a miss for Earth. A prominence lifted off from the southeast limb at around 11/2140 UTC with material possibly being emitted from AR3920 at around the same time. This is awaiting further analysis with a potential halo present in imagery. The large north-south filament in the southwest continued to show movement, but appears to have been reabsorbed as no material was observed erupting.

Solar Wind / Geomagnetic Activity: Slow ambient winds dominated through the period with solar wind speeds, observed at L1 by ACE around 360-380km/s. Density was below average. The Interplanetary Magnetic Field (Bt) was weak at 3-6nT with the north-south component (Bz) fluctuating at times but trending mainly negative (southwards), ranging -5 to +4nT. The Phi angle was mainly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at background. High energy electron flux (greater than 2MeV) observed by GOES16 showed a diurnal variation from background to moderate, peaking 802 pfu at 11/1610 UTC. The associated 24-hour fluence was below Active, with the 12/0000 UTC observation of 2.27e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Isolated M-class flares are likely throughout the period with a very slight chance of X-class flares.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

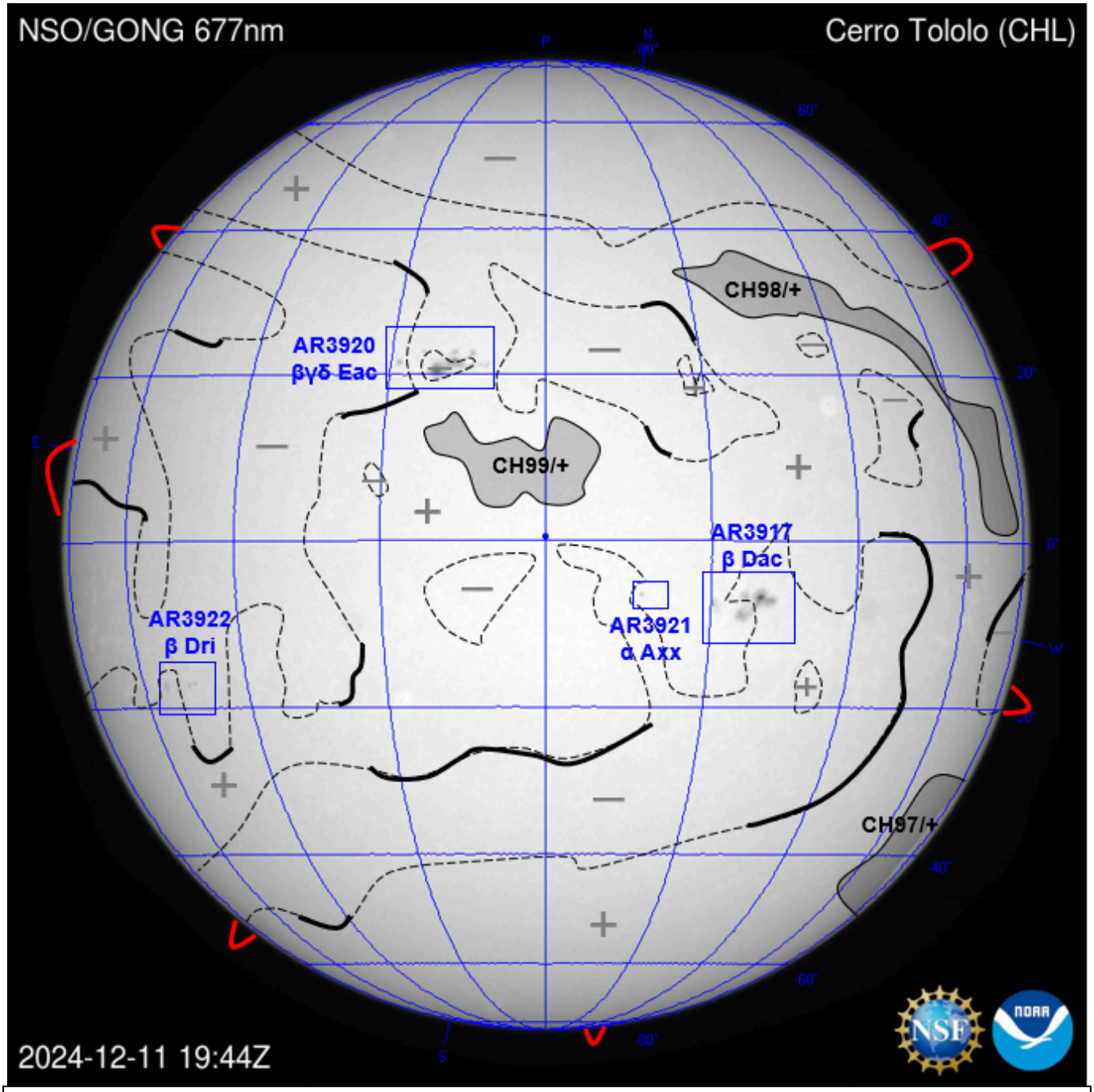
Solar Wind / Geomagnetic Activity: There are no Earth directed CMEs. A prominence lifted off from the southeast limb at around 11/2140 UTC with material possibly being emitted from AR3920 at around the same time. This is awaiting further analysis with a potential halo present in imagery. Background winds are expected to persist with only slight enhancements possible from any interaction with the fast wind from CH98 across the north disc. The next main fast wind onset is likely to be from CH99, on Day 3 (14 Dec) and into Day 4 (15 Dec). Geomagnetic activity is forecast to be Quiet with a chance of isolated Unsettled intervals. This increasing to give Unsettled to Active, with a slight chance of G1 Minor Storm intervals on Days 3 and 4 (14-15Dec) if any connection to CH99 occurs.

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain at background with only a slight chance of rising in response to any notable flares. High energy electron flux is expected to persist at background to moderate, but likely dropping out to persistently background if any fast wind onset occurs on Day 3 (14 Dec). The 24-hour fluence is expected to remain below the Active threshold.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 1: Solar Synoptic Map valid 11/1944 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Storms

There are currently no Earth-directed CMEs. However, a prominence lifted off from the southeast limb at around 11/2140 UTC with material possibly being emitted from AR3920 at around the same time. This is awaiting further analysis with a potential halo present in imagery.

Fast winds from the connection to the southern lobe of CH98 look to have largely passed with solar winds at background speeds. While CH98 is extended eastward across the northern disc, any further connection is likely to be minimal, bringing just a chance of brief periods of slightly elevated solar winds. The next enhancement is expected from the fast winds of CH99, which is currently approaching the centre disc. This is a persistent feature, and was likely the cause of a weak enhancement that occurred on the previous rotation on 18 Nov. This resulted in winds speeds of around 450 km/s, and would map to this rotation to give an arrival on Day 4 (15 Dec) and perhaps earlier if a stronger fast wind is observed. That being said, with the slightly elevated winds from CH99s previous rotation, there was little impact on the geomagnetic activity. However, if we see any prolonged negative Bz intervals there is a slight chance we could see G1/Minor Storms.

Enlil is currently showing a weak enhancement on 14 Dec, which is currently believed to be too quick in connecting to the HSS from CH99. Enlil also suggests Earth will continue to see a weak connection to CH98 for much of the period, which is not agreeing with current observations, leading to very low confidence in this guidance.

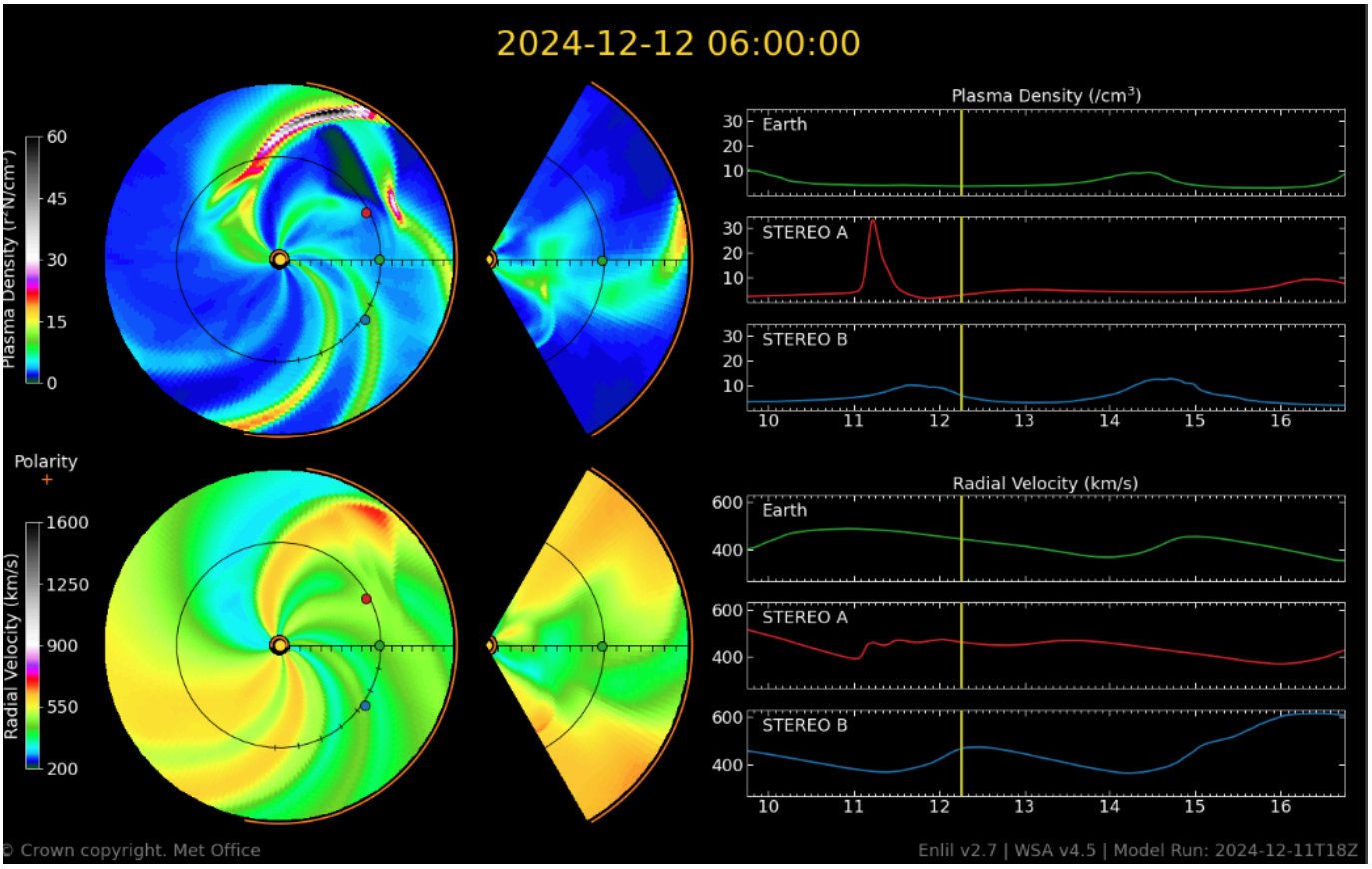
Overall, mainly Quiet geomagnetic activity is expected with a chance of isolated Unsettled intervals. This increasing to give Unsettled to Active, with a slight chance of G1 Minor Storm intervals on Day 3 and 4 (14-15 Dec) if any connection to CH99 occurs.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	1	1	5	10
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 2: MOSWOC Enlil output is regarded with caution.



© Crown Copyright 2024. All Rights Reserved.

Radio Blackouts - X-Ray Flares

There are currently four active regions on the disc, and although this is lower than recent days, three of the sunspot regions have the potential for notable flares. AR3922 in the southeast of the disc, gave several M-class flares as it rotated around the southeast limb. However, this remains a small and relatively simple region in recent imagery, although it is proving difficult to analyse in its current location and with the lower resolution SUVI imagery. AR3917 now moving across into the southwest disc, has shown some consolidation of its smaller spots into a few larger ones. AR3920, which has seen frequent C-class flaring along with providing the peak M-class flare in the last 24 hours, has been developing through the last 24-48 hours with ongoing flux emergence and increase in penumbral extent. This has also developed some slight magnetic complexity with evidence of a potential delta spot. AR3921 remains magnetically simple.

We continue to see notable magnetic looping from around the southeast limb, with perhaps Ex-AR3899 and Ex-AR3901 expected around the limb by Day 3 (14 Dec), both of which produced notable flares on its previous rotation, although this is viewed with some uncertainty at present.

Isolated M-class flares are likely throughout the period with a very slight chance of X-class flares.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	60	60	65	65
Very Active	R3-R5 (X Class)	No	5	5	5	5

Figure 3: GOES16&18 X-ray trace.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Solar Radiation Storms (High Energy Protons)

GOES18 proton flux is currently at background, and is expected to persist at this level, with only a very slight chance of rising in response to any notable flares. This risk perhaps increasing later in the period as the current regions, including AR3917 and AR3920 move into and across the better connected western hemisphere.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

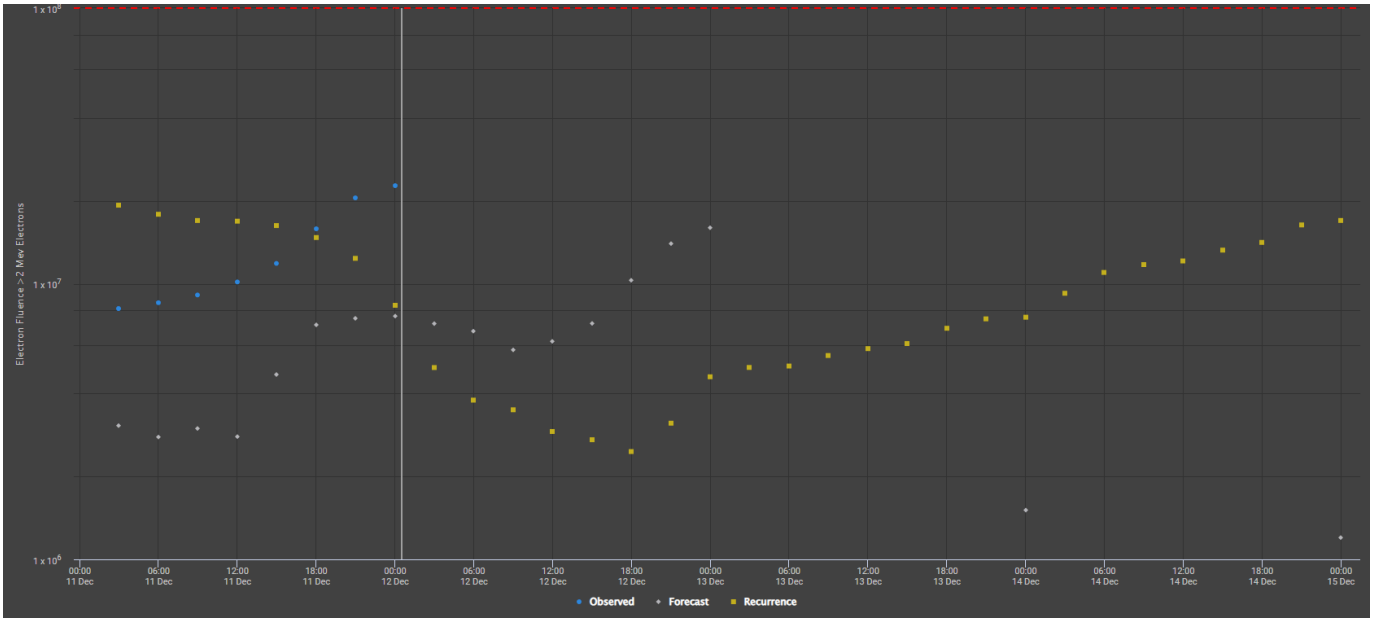
High Energy Electrons (≥ 2MeV)

High energy Electron flux observed by GOES16 showed a diurnal increased from background levels to moderate with a similar trend likely to continue. Recent solar wind enhancement from the fast wind of CH98 was relatively subdued in terms of geomagnetic activity, despite peaking at around 500 km/s. This likely limited the charging of the Van Allen Belts, and any subsequent electron flux that will be observed through this period. Subsequently Background to moderate flux is expected, perhaps approaching high at diurnal peaks. A very slight chance that if the diurnal peaks remain high for over 24 hours the fluence may reach moderate levels. Any arrival of the fast winds of CH99 later in the period will likely drop out values at GEO, to mainly background.

The associated 24 hr fluence is expected to remain below Active. The MOSWOC REFM forecast is currently underestimating the expected fluence, with a slight upward trend more likely, however the overall forecast for fluence to remain below Active.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	5	5	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 4: MOSWOC REFM output.



© Crown Copyright 2024. All Rights Reserved.